

REMARKS

Reconsideration of the above-identified patent application, as amended, is respectfully requested. The present amendment is responsive to the Office Action mailed February 6, 2003. A petition for an extension of time in which to respond to the Office Action accompanies this amendment.

By the present amendment, claims 1-13, 17-24 and 31 are pending in the application.

Restriction Requirement

Applicants hereby affirm the election, with traverse, of claims 1-13, 17-24 and 31 for prosecution in this application.

This election is made with traverse because, although the applicants submit that all the claims are separately patentable, applicants believe that the claims are sufficiently related to be properly presented in a single application.

This election is made without prejudice to the filing of divisional application(s) directed to the non-elected claims.

Claim Amendments

Non-elected claims 34, 38 and 39 have been canceled without prejudice to the filing of divisional application(s) directed to the non-elected claims.

Claim 31 has been amended at line 13 of prior claim 31 to read -- and on the surface, fine ...--.

Support for this amendment may be found in the specification, e.g., at page 76, lines 4-7.

New matter is not being presented by the present amendment.

Drawings

In response to the objection to Fig. 1, enclosed is a sketch of a proposed amended Fig. 1 marked in red wherein Fig. 1 is designated by the legend --Prior Art--.

In response to the objection to Fig. 23, the specification has been amended at page 78, lines 10-11 to change "laser beam 14" to --laser beam 24--. Therefore, item 24 in Fig. 23 is now described in the specification.

In response to the objection to Fig. 25, enclosed is a sketch of a proposed amended Fig. 25 marked in red wherein item "10" is proposed corrected to item "28".

Fig. 34 was objected to in the Office Action. There is no Fig. 34 in the application. The applicants believe that the Office Action is actually objecting to Fig. 24.

In response to the assumed objection to Fig. 24, enclosed is a sketch of a proposed amended Fig. 24 marked in red wherein item "30" has been deleted from Fig. 24.

If the applicants assumption as to the objection to Fig. 34 appearing in the Office Action is incorrect, clarification is requested in the next communication from the Patent and Trademark Office.

In view of the proposed drawing corrections and the amendment to the specification, it is respectfully requested that the objections to the drawings be withdrawn.

Specification

In response to the objections of the Office Action to the specification, page 39, page 53, page 59, page 63, page 72, page 81 and page 92 of the specification have been amended to delete references to the claims.

Page 62, line 24 of the specification was objected to because reference was made to the claims. There is no reference to the claims made on Page 62 of the specification. Clarification of this objection is respectfully requested in the next communication from the Patent and Trademark Office.

The Office Action objected to the specification at page 78, line 9 on the grounds that Fig. 23 should be Fig. 24. Applicants respectfully disagree and submit that Fig. 23 is correct. The description of Fig. 24 starts at page 90, line 17 of the specification.

In view of the present amendment and foregoing remarks, it is respectfully requested that the objections to the specification be withdrawn.

§103

Claims 20 and 21 were rejected under 35 U.S.C. §103(a) as being unpatentable over Japan No. 09-103849 in view of U.S. Patent No. 4,887,662 to Tanaka et al.

This rejection is respectfully traversed.

The Present Invention

Features Of Claim 20

1. The present invention of Claim 20 is characterized by:

1(a) dimples 40 to 200 μm in average depth and 0.5 to 3 mm in diameter of circle equivalent, adjacent to each other at the rims of said dimples (refer to Fig. 6), and

1(b) a film containing a substance more excellent than Ni in wettability with scum.

In addition, both the dimples and the film are formed on the plated peripheral surface of the cooling drum.

Features Of Claim 31

2. the present invention of Claim 31 is characterized by:

2(a) the thermal conductivity of the base material of the drum being not less than 100 w/m \cdot k;

2(b) an intermediate layer 100 to 2,000 μm in thickness having the coefficient of thermal expansion of 0.50 to 1.20 times that of said drum base material and Vickers hardness Hv of not less than 150 being coated on the surface of said drum base material;

2(c) a hard plated layer 1 to 500 μm in thickness having Vickers hardness Hv of not less than 200 being applied on the outermost surface;

2(d) dimples 200 to 2,000 μm in diameter and 80 to 200 μm in depth being formed so as to contact each other or be adjacent to each other on the surface; and

2(e) fine holes on the surface which are 50 to 200 μm in diameter and 30 μm or more in depth being formed so as to have the pitch of 100 to 500 μm but not to contact each other.

Effects Based On The Features

Claim 20

The feature "1(a)" has an effect to disperse stress and strain exerted on a solidified shell, and as a result, to reduce the macroscopic stress and strain exerted on the solidified shell (refer to lines 8 to 11 on page 66 in the description).

The feature "1(b)" is the important one based on the finding (C) (refer to lines 28 to 31 on page 19 and line 15 on page 63 to line 1 on page 64) and has a significant effect not to generate solidification unevenness that induces "pickling-unevenness accompanying crack" (refer to line 2 to 10 on page 64 and Table 6 on page 71).

According to the synergy between the feature "1(a)" and the feature "1(b)", Claim 20 has the significant effect that a thin slab produced by using Claim 20 does not have "surface defects" such as "surface cracks and crevices", "pickling unevenness", and "pickling-unevenness accompanying cracks" (refer to lines 13 to 16 on page 98).

Claim 31

The feature "2(a)" has an effect to suppress the generation of thermal stress by maintaining the temperature

of the drum low, and as a result, to prolong the service life (refer to lines 11 to 15 on page 72).

The feature "2(b)" has an effect to prevent the peeling off of the intermediate layer by reducing the shearing stress attributed to thermal stress caused by the difference in the coefficient of thermal expansion between the intermediate layer and the drum base material (refer to lines 18 to 25 on page 72), an effect to prolong the service life by maintaining both deformation resistance and toughness required of the intermediate layer (refer to lines 1 to 7 on page 73). Another effect is to protect the drum base material thermally by avoiding the excessive rise of the surface temperature of the intermediate layer (refer to lines 8 to 13 on page 73).

The feature "2(c)" has an effect to maintain the abrasion resistance required of the outermost surface (refer to lines 22 to 30 on page 73).

The feature "2(d)" has an effect to make the solidification-contraction stress dispersed and relaxed by the generation of solidification nuclei, and as a result, to suppress the occurrence of cracks and uneven luster on a thin slab (refer to lines 6 to 20 on page 74, line 32 on page 74 to line 17 on page 75 and Figs. 21 and 22).

The feature "2(e)" is unique to the present invention and has a significant effect to suppress the occurrence of unevenness of the solidification even at the

portions where scum was carried in (refer to line 18 on page 75 to line 34 on page 76 and Figs. 21 to 22).

According to these features, especially both the feature "2(d)" and the feature "2(e)" which have a close relationship in view of diameter (refer to line 32 on page 74 to line 4 on page 75), a Claim 31 has the significant effect that a thin slab produced by using Claim 31 does not have "surface defects" such as "surface cracks and crevices", "pickling unevenness", and "pickling-unevenness accompanying cracks" (refer to Table 7 on page 80 and lines 13 to 16 on page 98).

The Prior Art

JP09-103849 (JP '849)

JP '849 disclose recessed parts (refer to "d" in Figure and correspond to "dimple") having 30 to 150 μm average depth formed on the surface of the Co layer. The recessed parts, however, are not adjacent to each other at the rims of the recessed parts, as shown in figures in JP '849.

In other words, the recessed parts do not contact each other.

That is, the existence mode of the recessed parts that are formed on the plated peripheral surface of the cooling drum, in JP '849, is different from that of the "dimples" of the present invention, which is shown in Fig. 6 (especially refer to Fig. 6(b)), though the Office Action

notes that the recessed parts are formed adjacent to one another in JP '849.

Also, JP '849 does not disclose or suggest the recessed parts having a diameter of 0.5 to 3 mm in circle equivalent or 200 to 2,000 μm , or having any spacing or pitch on the plated peripheral surface of the cooling drum.

Therefore, the recessed parts disclosed in JP '849 do not disclose or suggest the "dimples" in the present invention, that is, JP '849 does not disclose or suggest the feature "1(a)" (Claim 20) and the feature "2(d)" (Claim 31).

Furthermore, JP '849 does not disclose or suggest the feature "1(b)" (Claim 20) and the feature "2(e)" (Claim 31) because no technical matters related to wettability with scum or formation of fine hole are described in JP '849.

Also, JP '849 does not disclose or suggest the above-mentioned effects based on the features of Claim 20 and Claim 31.

Therefore, JP '849 does not disclose, suggest or teach Claim 20 and Claim 31.

U.S. Patent No. 4,887,662 (USP '662)

USP '662 discloses numerous dimples disposed uniformly and not in contact with each other on the surface composing part of a casting mold wall (refer to Claim 1 and Fig. 1, Fig. 12A and Fig. 12B).

Furthermore, USP '662 disclose controlling the dimple opening portion diameter and the inter-dimple distance

in order to rationalize the mutual relationship between the solidified shell and the air gap that are formed between the solidified shell and the drum surface and work as a heat insulating layer to make the growth rate of the shell lower, and as a result, to cause less stress concentration forming cracks in the solidified shell (refer to lines 25 to 58 on column 6 and Figs. 7 and 8).

However, the dimples disclosed in USP '662 are the ones that should be formed to exist just on the "smooth surface" composing part of a casting mold wall (refer to lines 53 to 56 on column 4 and Fig. 3).

Therefore, from the view point of the existence mode of dimple on the surface of cooling drum, the dimples disclosed in USP '662 are different from the "fine holes" characterized by the feature "2(e)" of Claim 31, where the "fine holes" are the ones formed so as to have the predetermined diameter and pitch and not to contact each other on the surface.

That is, the "fine holes" of Claim 31 are the ones that are formed on the surface having the dimples 200 to 2,000 μm in diameter and 80 to 200 μm in depth, being formed so as to contact each other or be adjacent to each other thereon (refer to the feature "2(d)") in order to resolve the problem that, in the prior art casting using a cooling drum having only the dimples, the unevenness of solidification causing cracks and unevenness on the surface of the shell or

slab may take place between the portions where scum flows in and the sound portions of the slab, and the present invention has a significant effect to suppress the occurrence of unevenness of the solidification (refer to line 18 on page 75 to line 34 on page 76 and Figs. 21 to 22).

USP '662 does not disclose or suggest the problem caused by synergy between the dimples and the scum, and any technical matters resolving the problem.

Therefore USP '662 discloses or suggests the existence mode and function of the "fine holes" featured by the feature "2(e)" in Claim 31.

With reference to Claim 20, US '662 does not disclose or suggest feature "1(a)" of Claim 20 (dimples adjacent to each other) or feature 1(b) of Claim 20 (solving problems related to scum).

It is submitted that JP '849 could not be modified by the teachings of US '662 so as to arrive at the present invention as defined in Claim 20 and Claim 31.

It is therefore submitted that Claim 20 and Claim 31 are patentable over JP '849 in view of US '662.

Allowable Subject Matter

The applicants are pleased to note that the Office Action advises at page 6 that claims 1-13, 17-19 and 21-24 are allowed.

VERSION WITH MARKINGS TO SHOW CHANGES MADE

The following is a mark d version of amended claim 31.

--31. (Amended) A cooling drum for metal cast strip by continuous casting, characterized in that: the thermal conductivity of the base material of the drum is not less than 100 W/m·K; an intermediate layer 100 to 2,000 μm in thickness having the coefficient of thermal expansion of 0.50 to 1.20 times that of said drum base material and Vickers hardness Hv of not less than 150 is coated on the surface of said drum base material; a hard plated layer 1 to 500 μm in thickness having Vickers hardness Hv of not less than 200 is applied on the outermost surface; further on the surface, dimples 200 to 2,000 μm in diameter and 80 to 200 μm in depth are formed so as to contact each other or be adjacent to each other; and on the surface, fine holes 50 to 200 μm in diameter and 30 μm or more in depth are formed so as to have the pitch of 100 to 500 μm but not to contact each other.--

The following is a marked version of amendments to the specification.

Please replace the paragraph at page 39, lines 10-11, with the following amended paragraph.

1) [On the invention according to claims 1 to 12 and the invention related thereto.] A first embodiment of the present invention, which includes various sub-embodiments, will be described.

Please replace the paragraph at page 53, lines 1-2, with the following amended paragraph.

2) [On the invention according to claims 13 to 17 and the invention related thereto.] A second embodiment of the present invention, which includes various sub-embodiments, will be described.

Please replace the paragraph at page 59, lines 10-11, with the following amended paragraph.

3) [On the invention according to claims 18 and 19 and the invention related thereto.] A third embodiment of the present invention, which includes various sub-embodiments, will be described.

Please replace the paragraph at page 63, lines 3-4, with the following amended paragraph.

4) [On the invention according to claims 20 to 30 and the invention related thereto.] A fourth embodiment of the present invention, which includes various sub-embodiments, will be described.

Please replace the paragraph at page 72, lines 1-2, with the following amended paragraph.

5) [On the invention according to claims 31 to 33 and the invention related thereto.] A fifth embodiment of the present invention, which includes various sub-embodiments, will be described.

Please replace the paragraph at page 77, line 34 to page 78, line 12 with the following amended paragraph.

In the above explanation, the explanation on a cooling drum is made assuming that the cooling drum is manufactured and used according to the conditions specified by the present invention before being used for thin slab casting. However, when a plated layer material of the outermost surface which has a possibility of the fine holes being abraded along with the progress of casting is selected, it is also possible, as shown in Fig. 23, to employ a means of continuously forming fine holes on a cooling drum, during casting, by pulsed laser processing at a certain position after the drum surface leaves the molten steel. In the configuration shown in Fig. 23, it is possible to form fine holes in the peripheral direction by condensing the pulsed laser beam [14] 24 emitted from the laser oscillator 23 with a condenser 25 and irradiating the pulsed laser beam.

Please replace the paragraph at page 81, lines 1-2, with the following amended paragraph.

6) [On the invention according to claims 34 to 38 and the invention related thereto.] A sixth embodiment of the

present invention, which includes various sub-embodiments,
will be described.

Please replace the paragraph at page 92, lines 11-12, with the following amended paragraph.

7) [On the invention according to claims 39 and 40 and the invention related thereto.] A seventh embodiment of the present invention, which includes various sub-embodiments, will be described.

CONCLUSION

It is submitted that in view of the present amendment and foregoing remarks, the application is now in condition for allowance. It is therefore respectfully requested that the application, as amended, be allowed and passed for issue.

Respectfully submitted,

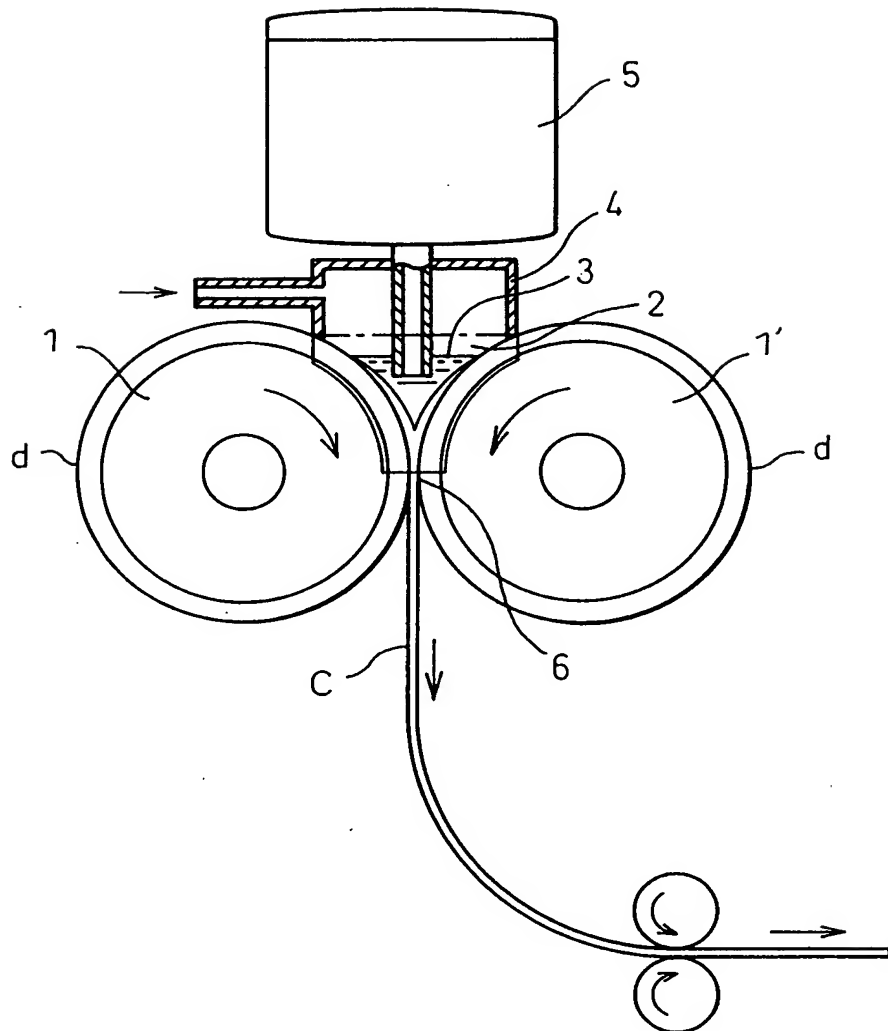
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Fig.1 *PRIOR ART*



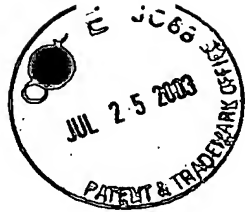


Fig. 24

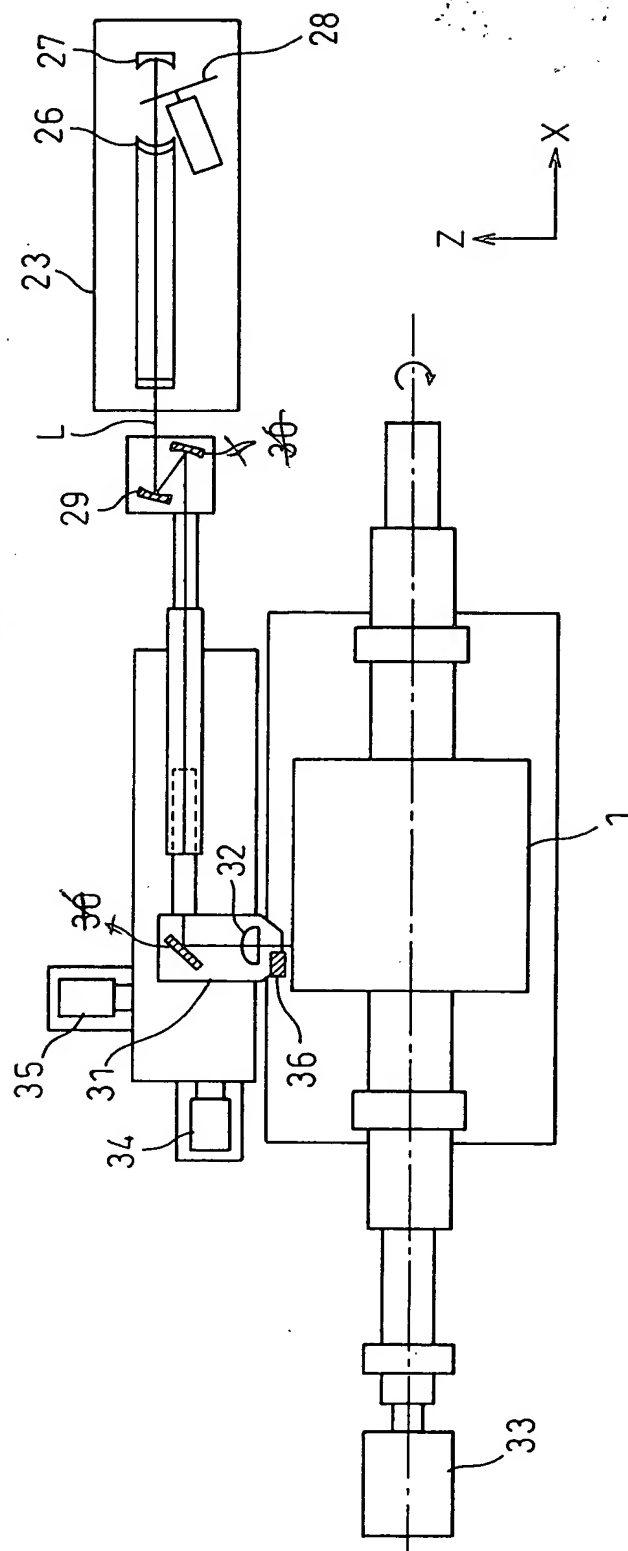




Fig. 25

